CROSS FUNCTIONAL TRAINING REPORT

RELIANCE ENGINEERING GROUP

JEC-CSA

(CIVIL STRUCTURAL & ARCHITECT)

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RPMG REG CSA GET BATCH 2025

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to all those who supported and contributed to the successful preparation of this project report during the cross-functional training program. I am especially thankful to the Learning and Development team for assigning us to this enriching one-month training program and for providing valuable learning opportunities throughout its duration.

I am deeply grateful to the management of **PV Solar** for granting us the opportunity to gain practical exposure and work within their esteemed organization. This experience has significantly enhanced my professional knowledge and understanding of industry practices.

I would like to extend my special thanks to my mentor **Mr. Sunil Agate (RPMG CM JMD NEI-Glass),** Planner **Mr. Manish Luvani, Mr. Vijaykumar B and Mr. Ahmed Qureshi (RPMG CM JMD NEI-Glass)** for his continuous support, guidance, and encouragement throughout the training period. I am also sincerely thankful to **Mr. Mohammed Rafeeq (RPMG CM JMD NEI-Glass) and Mr. Nurulain Modi (RPMG CM JMD NEI-Glass)** for his mentorship and valuable insights, as well as for facilitating interactive sessions that greatly enriched the learning experience. I would also like to thank my Manager **Mr. Vinaykumar S Pauskar** for continuos support from my joining day to till now**.** Their invaluable advice and consistent assistance played a crucial role in the successful completion of this project.

I would also like to acknowledge and thank the industry colleagues, particularly those with technical expertise, for generously sharing their time and knowledge. My sincere appreciation extends to my project team members and everyone else who contributed their skills, cooperation, and support during the training program.

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INTRODUCTION

The Dhirubhai Ambani Green Energy Giga Complex over 5,000 acres in Jamnagar with five giga factories for:

- Photovoltaic panels
- Fuel cell system
- Green Hydrogen
- Energy storage
- Power electronics

The INTEGRATED PV MANUFACTURING FACILITY consists of the following factories

- **Polysilicon Factory:** Producing raw material for solar wafers.
- **Glass Factory:** Manufacturing high-quality glass used in solar panels.
- **Ingot Factory:** Producing silicon ingots for wafer creation.
- **Wafer Factory:** Manufacturing thin slices of silicon for solar cells.
- **Cell Factory:** Producing solar cells that convert sunlight into electricity.
- **Module Factory:** Assembling solar cells into complete solar modules.
- **O's and U's (Offsites & Utilities):** Provides essential services like power, water, steam, compressed air, and other utilities required to run the factories
- **ETP (Effluent Treatment Plant):** Treats and cleans wastewater before it is reused or safely discharged, protecting the environment.
- **ASRS/POE:** Automated Storage & Retrieval System for material handling, and POE (Polyolefin Elastomer) used as an encapsulant to protect solar modules.

Reliance Industries Limited (RIL), one of India's biggest and most diverse companies, has started a new glass manufacturing factory. This factory will make special glass used in solar panels for its New Energy Solar Production Project.

This step supports Reliance's goal of becoming a major leader in renewable energy, especially solar power. It also helps India move towards cleaner and greener energy.

The new glass factory plays an important role in Reliance's clean energy plans. It will make high-quality solar glass, which is a key material needed to produce solar panels. By building this factory, Reliance wants to reduce India's dependence on imported solar materials and create a strong, local supply chain.

The factory will use modern technology to produce strong, long-lasting, and high-performance solar glass that meets international standards. This will help Reliance compete in the global renewable energy market while supporting India's efforts to reduce carbon emissions.

The construction of glass factory is carried by LARSEN & TOUBRO. The engineering consultant is TATA CONSULTING ENGINEERS LTD. The project is being monitored by RELIANCE INDUSTRIES LTD. There are many more companies (53) aligned to complete the project.

PURPOSE OF THE UNITS

The purpose of glass factory is to produce the glass required for the manufacturing of solar panels. The total plot area is 256.71 acres. There are two phases for this project. Train 1 & 2 are being built in phase 1.

For Phase 1

Plot area = 164.76 acres

Built up area = 73.68 acres

Green belt / landscape area = 17.81 acres

Road area with shoulder = 31.08 acres

Service area = 42.19 acres

Glass factory contains the following buildings:

A. **Comprehensive raw material storage (RMWH):** Stores raw materials.

Raw Materials Used in Solar Glass Manufacturing: Silica Sand (SiO_2), Soda Ash (Na_2CO_3), Limestone ($CaCO_3$), Alumina (Al_2O_3), Magnesium Oxide (MgO), Iron Oxide (Fe_2O_3), Barium Oxide (BaO), Strontium Oxide (SrO), etc.

B. **Batch house:** Weighs and blends raw materials like silica sand, soda ash, and limestone in specific ratios before they are fed into the melting furnace.

C. **Train 1**: Capacity of 1000 tonne glass per day

1. **Melting section-1:** Houses large furnaces made of zircone and monite where raw materials are heated to temperatures around 1,400°C - 1,600°C to form molten glass.
2. **Forming and annealing section:** The molten glass is passed over a bath of molten tin in the floating section to form flat sheets, then moved to the annealing lehr (cooling section) where it cools gradually to relieve thermal stresses.
3. **Cutting section:** Glass sheets are cut into the required dimensions for solar panel applications, using precision cutting machines.
4. **Deep processing workshop:** For additional processing of glass sheets, such as edge grinding, polishing, and adding coatings.

   • *Key Function*: Glass sheets are processed to improve optical properties, strengthen edges, and add anti-reflective coatings or other features as needed.
5. **Finished product warehouse:** Includes inspection for defects, packaging the finished glass sheets, and storing them until they are ready for shipment to solar panel manufacturing facilities.
6. **FG loading platform:** To safely handle, store briefly, and load finished solar glass sheets onto trucks or containers for dispatch to the next manufacturing stage or customers.

D. <u>Train 2</u>: Same process as in Train-1, Capacity of 1000 tonne glass per day

1. Melting section-2
2. Forming and annealing section
3. Cutting section
4. Deep processing workshop
5. Finished product warehouse
6. FG loading platform

E. <u>Utility Area</u>

1. **Canteen/Admin Building:** Canteen Provides hygienic food and refreshment facilities for employees, supporting worker health and productivity. Admin building for management offices, control rooms, meeting areas, and administrative functions for smooth plant operations. Canteen dimension is 70m×35m and admin buildings dimension is 70m×45m.
2. **Water tank:** Stores water at an elevated level to ensure continuous water supply with adequate pressure for process use, utilities, and firefighting needs in the glass factory.
   Dimension:
   Height= 41.850m,
   Shaft base inner and outer dia= 4.7m and 7.1m, 1.2m wall thickness
   Shaft top inner and outer dia= 4.7m and 5.7m, 0.5m wall thickness
   Tank Bottom, inner and outer dia= 5.7m and 7.1m
   Tank at top portion, inner and outer dia= 16.4m and 17m, 0.3m thick wall
   Tank is divided into 4 parts for better pressure resisting strength using the RCC walls.
   Roof slope provided in base of tank is 1:300
   It is 1m empty from top as L shaped outlet has been attached for excess water.
3. **Circulating water pump room:** Houses pumps and related equipment that circulate cooling water continuously to maintain required temperatures for glass manufacturing processes and plant utilities.
4. **NG station:** Receives, regulates, and supplies natural gas at required pressure and flow for furnaces, burners, and other thermal processes in the glass factory.
5. **HSD tank / FO tank:** Stores High Speed Diesel and Furnace Oil used as backup or supplementary fuel for generators, boilers, and emergency operations.
6. **Air station compressor:** Generates and supplies compressed air required for operating pneumatic equipment, instruments, and automation systems.
7. **PIB room:** Acts as the coordination hub between different plant units, housing control systems, communication equipment, and operational interfaces for smooth and integrated glass factory operations.

8. **Substation:** Receives high-voltage electricity, steps it down to required levels, and distributes power safely and reliably to various units of the glass factory.
9. **General store:** For receipt, storage, safe custody, and controlled issue of general materials, consumables, tools, and spare parts
10. **Packing material store:** Storage area for safe storage and controlled issue of packing materials used for product handling and dispatching.
11. **Refractory storage:** Refractory bricks (silica, alumina, magnesia, zircon, monite, etc.), Refractory castables and gunning materials, Insulating bricks and boards, Refractory mortars, cements, and bonding materials, Precast refractory shapes and blocks.
12. **STP-2:** Collection, treatment, and disposal or reuse of domestic wastewater generated from plant and administrative areas.
13. **Maintenance workshop**: For inspection, repair, servicing, and upkeep of plant equipment, tools, and machinery, ensuring reliable operation of the facility.
14. **Cullet storage yard:** An open or covered area designated for collection, segregation, and storage of cullet (recycled glass) prior to reuse in the glass manufacturing process.
15. **Security & time office:** plant security control, personnel entry–exit monitoring, and time attendance management**,** ensuring safe and regulated access to the premises.
16. **Chiller unit:** mechanical system used for cooling water or process fluids to maintain desired temperatures in plant operations, air-conditioning, or equipment cooling.
17. **Chimney-WHR:** A vertical structure designed to discharge flue gases from the Waste Heat Recovery system safely into the atmosphere.
18. **Weigh bridge cabin:** For weighing vehicles and materials entering or leaving the plant, ensuring accurate measurement, record-keeping.
19. **Grinding wheel:** A disc or cylindrical tool made of bonded abrasives (like aluminum oxide or silicon carbide), mounted on a spindle, rotated at high speed, and applied to workpieces to achieve the required surface finish, used in workshops for grinding, cutting, and finishing metal components with precision.
20. **Arc liquid manufacturing:** Production of arc liquids used in industries, involving controlled electrical arc reactions or chemical processes.

F. **<u>Train 3</u>:** Capacity of 1200 tonne glass per day

Its soil investigation is going on. There sample collection has been done which giving results for water level at 2m depth. There the temporary office area has been made for seem-less connectivity and better inspection in train 1 & 2 sites.

Much space is also left for future buildings and utilities for expansion and smooth operations.

KEY TAKE HOME LEARNINGS

1. Sample Collection

It is to be done by many methods if soil is soft then core cutter method, but there due to hard rock strata, bore hole cutting method used. 5 nos. of 1.5 m rods to do 15m sampling giving 10 samples at different depth. Upto 4.5m gravel, after that rocky sample were found. Water table is detected after 24 hrs. Samples of 75mm dia collected.

Fig.1.1 Sample pic at 7.5-9m depth from GL

Fig.1.2 Sample at every 1.5m depth (upto 7.5m)

Fig.1.3 Bore hole cutting method machine

2. Area Grading

Surface dressing is the initial earthwork activity for Greenfield projects and is sometimes required in Brownfield projects. It includes

a) clearing and grubbing, b) stripping of topsoil, and c) rough grading.

Temporary benchmarks are established based on layout drawings to guide survey coordinates and levels, taking care not to disturb boundary or permanent marks. Structural excavation is carried out as per foundation layouts, with additional space for workers, machinery, and shuttering as specified in the contract or instructed by the Engineer-in-Charge. If the founding strata is deeper than indicated in the drawings, the difference is filled with PCC or plum concrete. Excavated areas are securely barricaded and provided with caution signs and illumination to ensure safety during day and night operations. Fill material may be sourced from excavated soil, borrow pits, or off-site, and must be free of organic matter and rocks larger than 75 mm, which are removed during spreading, providing a safe and level base for further construction.

Physical properties of material:

Material Properties	Acceptance Limit
Max Dry Density Value (KN/m3)	Not less than 17.5KN/m3
Plasticity Index	6 to 20
Liquid Limit	Maximum 40%
Free swelling Index	Not exceeding 50%

Table 1

Before filling commences the area shall be proof rolled with at least four passes of a 10-ton vibratory roller.

- Filling shall be placed in layer. The compacted thickness of each layer shall be;
  A. **200mm** maximum for area less than 2000sqm
  B. **300mm** maximum for area more than 2000sqm
- Each layer shall be properly watered and compacted to achieve 90% of modified. Proctor density or 95% of standard Proctor density at optimum moisture content.
- Compaction test with sand replacement method shall be carried out at;
  A. One test in **250sqm**/Each layer for Smaller area
  B. One test in **500sqm**/Each layer for Larger area
- Re-Compaction and Re-testing to be carried out until the desired field compaction density is achieved.

3. Paved area in ISBL

A paved area in the ISBL is a section covered with a durable surface, such as asphalt, concrete, or other hard materials, providing a stable, non-porous foundation. Construction begins with clearing the site of vegetation, debris, or existing structures, followed by excavation to the required depth (typically 6 inches to 2 feet, depending on soil and load requirements). The surface is leveled using instruments like laser levels or string lines. A granular layer of crushed stone or gravel (4–6 inches thick) is placed and compacted mechanically to provide drainage and a stable base. Geocells, honeycomb structures made from HDPE, are used within the granular layer for soil stabilization and erosion control, ensuring durability and structural integrity of the paved area.

Fig.3.1 Geocells

The formwork is constructed using wooden planks or metal forms along the perimeter of the slab area. The formwork defines the shape and boundaries of the slab and holds the concrete in place during curing. After that steel rebars or welded wire mesh are placed in the formwork for strength. Rebar should be placed according to the structural design requirements, typically in a grid pattern.

Fig. 3.2 Grade Slab Formwork

Here in glass factory warehouse, fibre reinforced concrete is being used along with rebars to enhance the strength. The concrete is poured and curing is done. Hardening of surface is done using a floor hardener (Nitoflor hardtop standard), it contains special hardwearing aggregates which improves abrasion resistance of the slab. The surface is smoothed using a floater and ride-on travel (ROT) machine. If the slab is too big expansion joints will be cut and filled with HDPE to accommodate for expansions.

Fig. 3.3 SFRC

4. Open Pitched Drain

An open-pitched drain is an uncovered, sloped drainage system used in industrial or construction areas to channel water away, preventing flooding, damage, and safety hazards.

Fig. 4.1 Open Pitched Drain

5. ISBL Closed Drainage System and Catch Basin

The ISBL closed drainage system is an enclosed network of pipes that safely conveys wastewater, stormwater, or process effluents away from critical areas. Catch basins are connected structures that collect surface water and trap debris or sediments before it enters the system, ensuring smooth flow and preventing blockages.

Fig. 5.1 Circular Culvert in ISBL Drainage

6. OWS System and Man Holes

OWS System to collect and transport oily wastewater from process or operational areas to treatment facilities, preventing contamination and environmental hazards.

Manholes provide access points for inspection, maintenance, and cleaning within the sewer network, ensuring smooth operation.

Fig. 6.1 OWS Sytem and Man Holes

7. Flexible Pavement

A pavement structure consisting of bituminous layers laid over a granular base and sub-base, designed to distribute traffic loads gradually to the subgrade and provide a smooth and durable riding surface.

Fig. 7.1 Flexible Pavement

8. Visit to Batching Plant (SKB) and Quality Control Lab

Concrete is a key construction material, and an in-house batching plant provides a cost-effective solution for large-scale projects. The plant produces concrete by accurately weighing and mixing cement, sand, aggregates, fly ash, and water in required proportions. It consists of three silos (two for cement and one for fly ash), a conveyor belt for aggregates, a bucket system feeding the central mixer, and a transit mixer for concrete discharge. A chilling unit is provided to cool the mixing water when required to control heat during mixing. The plant has a theoretical capacity of 60 Cum/hr, with an actual production rate of about 48 Cum/hr, and concrete wastage is limited to 3% as per company standards.

Fig.8.1 Batching Plant

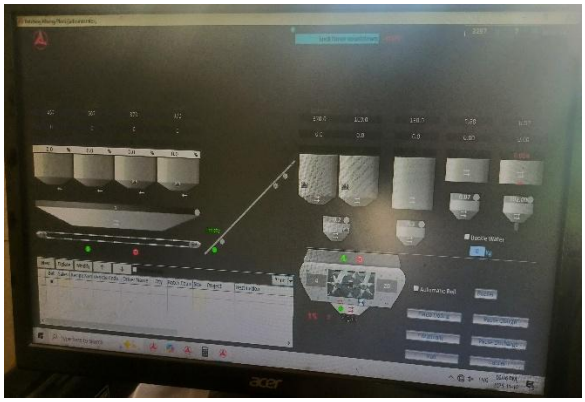
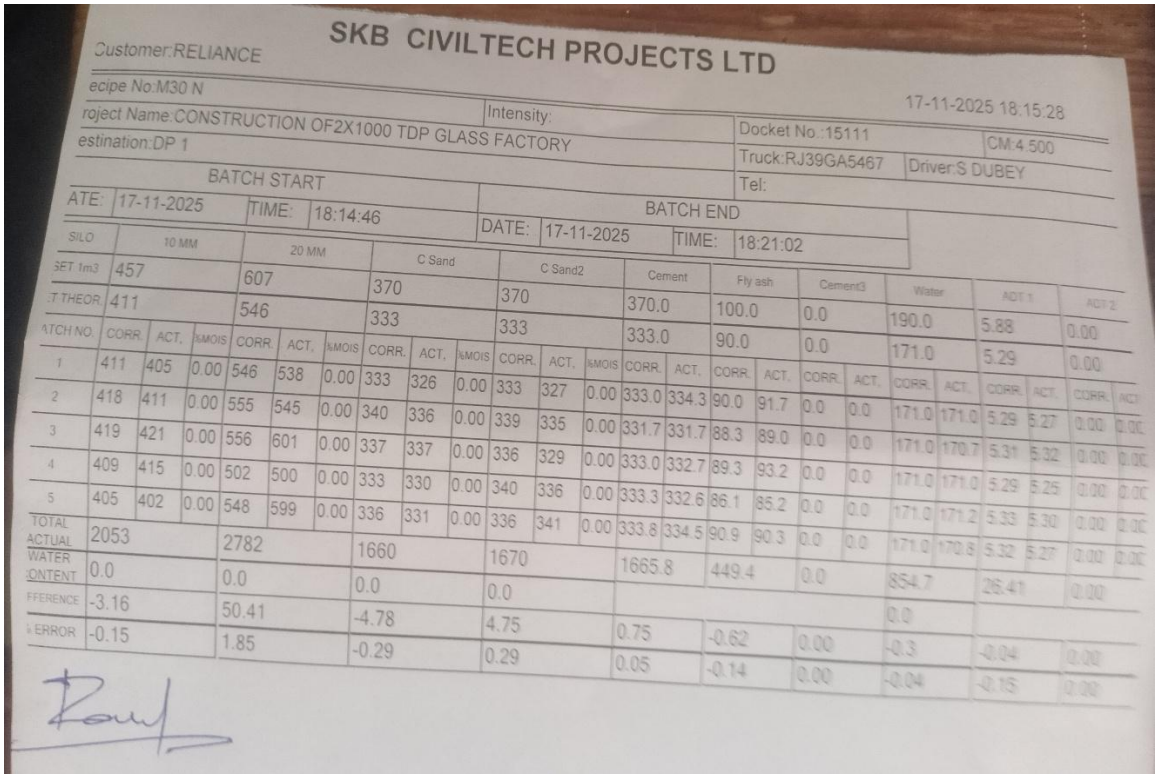


Fig. 8.2 Batching Plant Computer Interface



SKB CIVILTECH PROJECTS LTD

Customer:RELIANCE

ecipe No:M30 N

roject Name:CONSTRUCTION OF2X1000 TDP GLASS FACTORY

estination:DP 1

17-11-2025 18:15:28

Intensity:

Docket No.:15111

CM:4.500

Truck:RJ39GA5467

Driver:S DUBEY

Tel:

BATCH START

ATE: 17-11-2025 TIME: 18:14:46

BATCH END

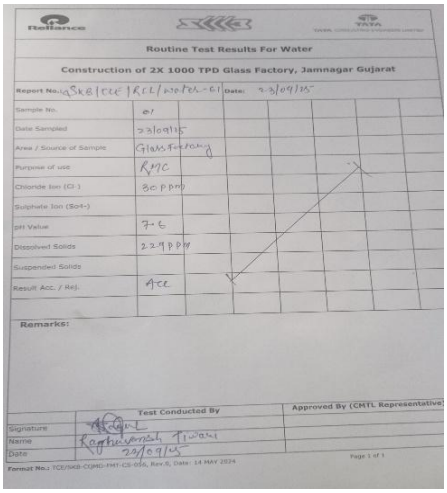
DATE: 17-11-2025 TIME: 18:21:02

SILO	10 MM			20 MM			C Sand			C Sand2			Cement		Fly ash		Cement3		Water		ADT 1		ADT 2	
SET 1m3	457			607			370			370			370.0		100.0		0.0		190.0		5.88		0.00	
T THEOR	411			546			333			333			333.0		90.0		0.0		171.0		5.29		0.00	
ATCH NO.	CORR.	ACT.	%MOIS	CORR.	ACT.	%MOIS	CORR.	ACT.	%MOIS	CORR.	ACT.	%MOIS	CORR.	ACT.	CORR.	ACT.	CORR.	ACT.	CORR.	ACT.	CORR.	ACT.	CORR.	ACT.
1	411	405	0.00	546	538	0.00	333	326	0.00	333	327	0.00	333.0	334.3	90.0	91.7	0.0	0.0	171.0	171.0	5.29	5.27	0.00	0.00
2	418	411	0.00	555	545	0.00	340	336	0.00	339	335	0.00	331.7	331.7	88.3	89.0	0.0	0.0	171.0	170.7	5.31	5.32	0.00	0.00
3	419	421	0.00	556	601	0.00	337	337	0.00	336	329	0.00	333.0	332.7	89.3	93.2	0.0	0.0	171.0	171.0	5.29	5.25	0.00	0.00
4	409	415	0.00	502	500	0.00	333	330	0.00	340	336	0.00	333.3	332.6	86.1	85.2	0.0	0.0	171.0	171.2	5.33	5.30	0.00	0.00
5	405	402	0.00	548	599	0.00	336	331	0.00	336	341	0.00	333.8	334.5	90.9	90.3	0.0	0.0	171.0	170.8	5.32	5.27	0.00	0.00
TOTAL ACTUAL	2053			2782			1660			1670			1665.8		449.4		0.0		854.7		26.41		0.00	
WATER ONTENT	0.0			0.0			0.0			0.0									0.0					
FFERENCE	-3.16			50.41			-4.78			4.75			0.75		-0.62		0.00		-0.3		-0.04		0.00	
% ERROR	-0.15			1.85			-0.29			0.29			0.05		-0.14		0.00		-0.04		-0.15		0.00	

Fig.8.3 Example of paperwork request of Batching of concrete

Table 2: Limits for Solids in Water

S.No.	Item	Max. Limit
1.	Organic	200 mg/l
2.	Inorganic	300 mg/l
3.	Sulphates (as SO3)	400 mg/l
4.	Chlorides (as Cl) for plain concrete	2000 mg/l
5.	Chlorides (as Cl) for RCC	500 mg/l
6.	Suspended Matter	2000 mg/l


Routine Test Results For Water

Construction of 2X 1000 TPD Glass Factory, Jamnagar Gujarat

Fig.8.4 Example of Water Test

9. Visit to construction site in progress (Foundations/Super Structure)

- Construction machinery encompasses a wide variety of specialized equipment, each designed for specific tasks to enhance efficiency and safety on construction sites. **Excavators**, such as crawler and wheeled types, are used for digging and material handling, while **bulldozers** with large blades are used for grading and land clearing. **Loaders**, including wheel and skid-steer versions, are ideal for lifting and transporting materials. **Cranes**, like mobile, tower, and crawler cranes, are essential for lifting heavy loads. **Concrete mixers** prepare the concrete, while **dump trucks** transport materials across the site. **Backhoe loaders** combine digging and lifting capabilities, and **compactors** like plate and roller compactors are used to ensure soil and asphalt are properly compacted. **Forklifts** are employed for stacking and moving materials, and **scrapers** help with earth removal and levelling**. Pile drivers** are crucial for foundation work, while **graders** are used for road construction and surface levelling**. Boom placers** with their extendable arm are used to pour concrete into difficult places. And **asphalt pavers** are used for laying smooth road surfaces. **Telehandlers**, with their extendable arms, offer versatile lifting solutions, making construction operations more effective and streamlined.

Fig. 9.1 Super-Structure

- A **cover block** is a small concrete or plastic block used in construction to maintain the correct spacing (cover) between the reinforcement (rebars) and the surface of the

concrete. The purpose of the cover block is to ensure that the steel reinforcement is adequately protected from environmental factors like moisture, chemicals, or fire, which could lead to corrosion or weakening of the structure.

- A **thermocouple** is used to measure the temperature of fresh or hardened concrete. It is typically embedded within the concrete at the time of pouring, often in multiple locations within a large pour. This ensures that the temperature distribution throughout the concrete mass is accurately measured.
- The reaction between water and cement is **exothermic**, releasing heat during hydration, with Ordinary Portland Cement generating about **82–83 Cal/gm of heat at 7 days**. Concrete is a poor conductor of heat; in **thin sections**, heat generation and dissipation occur at comparable rates, causing no major issues. However, in **thick sections**, heat generation initially exceeds heat dissipation due to slower transfer of heat from the core to the surface, leading to **heat accumulation and rise in core temperature**, which can exceed **80 °C** if not controlled. This excessive temperature rise can lead to **durability-related issues** in the concrete element or structure.
- A temperature differential develops between the concrete core and its surface, with the surface remaining in thermal equilibrium with ambient conditions. This thermal gradient induces tensile stresses in the concrete, which can cause cracking if the induced stresses exceed the tensile strength of concrete.

  At temperatures exceeding 70 °C, the risk of Delayed Ettringite Formation (DEF) increases, where early high temperatures inhibit normal ettringite formation during hydration. Sulphates later precipitate under favorable conditions such as high humidity, porosity, or microcracking, forming expansive products that exert internal bursting forces, leading to cracking. DEF may develop gradually and can take several years to manifest.

- **Mass Concrete:** The definition of mass concrete depends on multiple factors such as type of cement, concrete grade and mix design, use of supplementary cementitious materials and admixtures, geometry and dimensions of the element, hydration characteristics, type of aggregates and formwork, concrete placement temperature, curing method, insulation (if any), and environmental conditions including ambient temperature, wind speed, cloud cover, and relative humidity.

  Any combination of these parameters that has the potential to raise the core concrete temperature above 70 °C is classified as mass concrete. Generally, any concrete element having a minimum dimension of 1.0 m or more is considered as mass concrete.

- **Slip Formwork:** It is a construction technique used for continuous vertical structures such as walls, columns, and silos. It uses a movable formwork system that gradually moves upward as concrete is placed and gains strength, allowing the construction of tall structures without the need for conventional static formwork.

10. Cable Trench and Duct Bank

A cable trench is an **open or covered channel** used for laying and protecting electrical and instrumentation cables, allowing easy access for installation and maintenance. A duct bank is a **group of underground conduits encased in concrete** provided for routing and protecting multiple cables, ensuring safety, organization, and long-term durability.

Fig. 10.1 Cable trench and duct bank

Equipments

11. Exchanger / Horizontal Vessel

A **horizontal vessel or shell-and-tube heat exchanger** is mounted parallel to the ground and is widely used for heating or cooling fluids, consisting mainly of a shell, tubes, tube sheets, baffles, channel head, rear head, nozzles, and saddle supports; the **fixed end arrangement** has the tube sheet rigidly attached to the shell and is suitable for small temperature differences, while the **sliding (floating) end arrangement** allows axial movement of the tube bundle to accommodate thermal expansion and reduce stress; a **stacked heat exchanger** involves multiple exchangers arranged vertically to save plot space, commonly used where area is limited; and a **dish end** is a curved end closure (such as semi-spherical or ellipsoidal) used in vessels and exchangers to withstand pressure efficiently and reduce stress compared to flat ends.

Fig. 11.1 Horizontal vessel

12. Vertical Vessel

A **vertical vessel** is installed upright and commonly used for separation, storage, or reaction processes; it consists of a shell, heads, nozzles, internals, and is usually supported on an **equipment skirt**, which is a cylindrical support welded to the vessel bottom head to transfer loads safely to the foundation; the **bolt circle diameter (BCD)** is the diameter of the circle passing through the centers of anchor bolts and is selected to ensure stability against overturning and wind or seismic loads; **grouting of the vessel base plate** is done by filling non-shrink grout between the base plate and concrete foundation to ensure uniform load transfer, proper leveling, and corrosion protection, before that some drill should be provided for roughness and proper alignment; and an **equipment C-base plate (chair)** is a structural steel frame or chair arrangement provided below the skirt or base plate to distribute loads evenly and facilitate alignment and anchoring of the vertical vessel.

Fig. 12.1&2 Vertical Vessel

13. Pump

A **pump** is a rotating mechanical equipment used to transfer fluids by converting mechanical energy into hydraulic energy and mainly consists of the casing, impeller, shaft, bearings, seal, and coupling; the **pump base frame** (base plate) is a rigid steel structure that supports the pump and driver, maintains alignment, and transmits operating loads to the foundation while minimizing vibration; **pockets in the pump foundation** are recesses provided around the anchor bolts to allow bolt adjustment, proper alignment, and tightening, after which the pockets are filled with non-shrink grout (GP2) to secure the bolts and ensure effective load transfer and long-term stability of the pump installation.

Fig. 13.1 Pump, base frame, pockets in Foundation

14. Compressors

A **compressor** is a mechanical equipment used to increase the pressure of gases and is commonly used in process plants, supported on a **block foundation**, which is a massive reinforced concrete foundation designed to absorb dynamic loads, reduce vibration, and provide stability during operation; the **compressor foundation bolts** (anchor bolts) are embedded or sleeved in the concrete foundation to securely fasten the compressor base frame to the foundation, maintain proper alignment, resist operating and dynamic forces, and ensure safe and reliable long-term operation, with final tightening and grouting carried out after alignment is completed.

Fig. 14.1 Compressor

Structures

15. Pipe Rack

A **pipe rack** is a structural framework used to support process piping, cable trays, and sometimes equipment, where **longitudinal beams** run along the pipe direction and are fixed to **transverse frames** (bents) using shear or moment connections depending on load and stiffness requirements; an **expansion bay** is a deliberately widened bay provided at intervals to accommodate thermal expansion of long pipelines; pipe racks are commonly of **steel** (preferred for flexibility, speed of construction, and expansion) or **concrete** (used for heavy loads, durability, and fire resistance); **fin fan coolers** may be arranged on top of the rack with supporting steel and maintenance access, while a **cantilever header structure** is often provided on the side of the rack to support large headers without obstructing main rack space.

Fig. 15.1 Pipe Rack

Shear connections allow rotation and transfer mainly vertical loads, whereas **moment connections** resist bending and provide rigidity; **fireproofing on steel racks** (using concrete encasement or intumescent coating) is applied in fire-risk areas to maintain structural integrity; and **steel gusset plates** are used at beam–column joints or bracing connections to strengthen load transfer and improve overall stability of the rack.

16. CPS / Platforms

CPS/platforms are steel access structures provided around equipment and piping for operation and maintenance, supported on beams, columns, or racks; **T-posts and goal posts on grade** are freestanding supports erected at ground level to carry pipelines or cable trays across roads or open areas; **pipe support arrangements** include **rest supports** (allow vertical movement), **guide supports** (restrict lateral movement), **anchor supports** (fully restrain movement), and **spring supports** (absorb vertical movement due to thermal expansion); **sleepers** are low concrete supports used to carry pipes close to ground level, while **trestle supports** are framed supports used for pipelines crossing drains, roads, or uneven terrain; **cable tray supports on racks** are usually brackets or secondary beams fixed to pipe racks, and **cable tray riser supports** are vertical frames supporting trays where they rise between elevations; **platforms in compressor houses** provide access to compressors and auxiliaries, whereas **vessel circular platforms** are ring-type platforms fixed around vessels for valve and instrument access; **cage ladder arrangements** consist of vertical ladders with safety cages fixed to vessels or structures using brackets and anchor bolts; and **PSV platforms** are dedicated access platforms provided near pressure safety valves to allow safe inspection, operation, and maintenance.

Fig. 16.1 Sleeper and T post, Rest,Guide support

Fig. 16.2 Monkey ladder, Goal Post

Fig. 16.3 Trunion support

17. Technology Structures

Technology structures are elevated steel or concrete frameworks provided to support process equipment, piping, and operating platforms in process plants where grade mounting is not feasible; the **arrangement of equipment on structures** is planned to ensure proper process flow, adequate maintenance clearances, safe access, load distribution, and vibration control, with heavier or dynamic equipment placed at lower levels and lighter static equipment at higher elevations; and **staircases** are an integral part of these structures, designed with suitable slope, width, landings, handrails, and headroom to provide safe and convenient access between different operating levels in compliance with plant safety and ergonomic requirements.

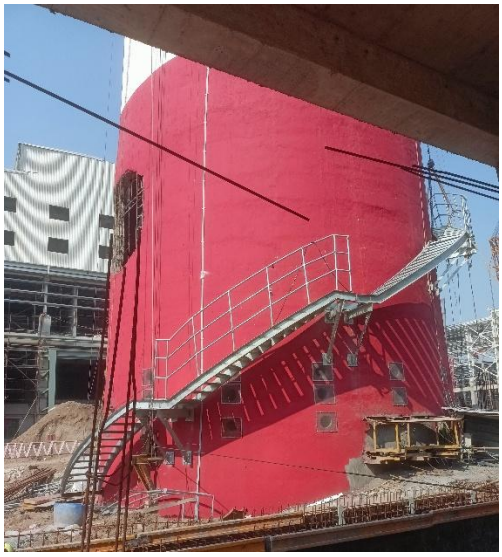


Fig. 17.1 Staircase

Fig. 17.2 Equipment on structure

18. Cooling Tower

A **cooling tower** is a heat rejection structure used to cool circulating water by evaporative heat transfer, commonly used in power and process plants; the **cooling tower basin** is the reinforced concrete structure at the boom that collects cooled water, while the **sump** is a depressed portion of the basin that ensures positive suction head and continuous water supply to pumps; **cooling tower pumps** are usually vertical or horizontal centrifugal pumps located near the basin to circulate cooling water to plant equipment and back to the tower; and **header pipe supports** are provided along the cooling water headers to safely carry pipe weight, accommodate thermal expansion, and maintain proper alignment, typically using concrete pedestals, steel trestles, or rack-mounted supports.

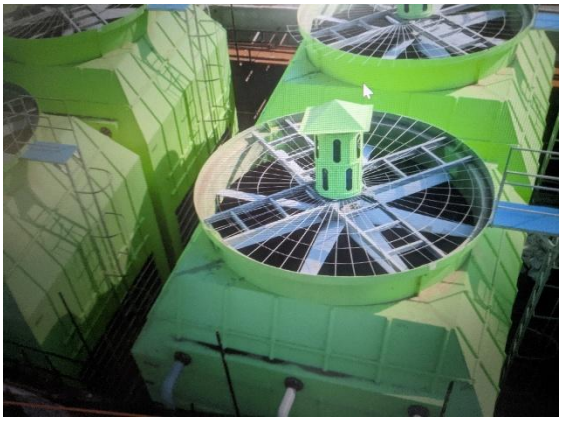


Fig. 18.1 Cooling Tower

Buildings

19. Sub-Station

A **substation** is an electrical facility that transforms voltage levels, distributes power, and houses control equipment; the **switchgear room** contains circuit breakers, relays, and switchboards for controlling and protecting electrical circuits, while the **cable cellar** provides a protected underground area for routing power and control cables; the **battery room** stores DC batteries for backup and emergency power, and the **HVAC room** accommodates heating, ventilation, and air-conditioning equipment to maintain optimal environmental conditions in electrical and control rooms; the **transformer bay**, typically located on the north side outside the substation, holds transformers with proper clearance for operation and maintenance; **waterproofing on buildings** is achieved using wire mesh and geotextile fibers to prevent water ingress, **dust-proof painting** protects equipment from dust accumulation, and **fire-rated doors** are installed in critical areas to prevent fire spread and ensure safety of person and equipment.

Fig.19.1 Sub-Station with Transformer Bay & fire rated doors

20. PIB / Control Room

A **PIB (Plant Interface Building) / Control Room** is a facility that houses control consoles, instrumentation panels, and interfaces connecting plant field equipment to the central control system; **access floors** are provided beneath the control room to neatly route wires, cables, and communication lines while allowing easy maintenance and future modifications; **control room consoles** are ergonomically arranged panels with operator interfaces, displays, and control instruments for process monitoring and operation; **fire-rated doors** are installed to protect the building and personnel in case of fire; and **blast valves** or **multiple cable transit systems** allow safe passage of cables through walls while preventing the spread of flames, smoke, or overpressure during high-risk events.

Fig. 20.1 PIB / Control Room

21. Compressor Building

A **compressor building** is a dedicated structure housing compressors, auxiliary equipment, and associated piping, designed to provide shelter, safety, and maintenance access; an **EOT (Electric Overhead Travelling) crane** inside the shed is used to lift and move heavy components such as compressor parts, motors, and pumps during installation or maintenance; **suction and discharge bottle pedestals** are reinforced supports for pulsation bottles or surge vessels connected to compressor suction and discharge lines, ensuring proper alignment and load transfer; and a **maintenance bay** is a designated area

within the building with sufficient space, overhead crane access, and supporting infrastructure for inspection, repair, and replacement of compressors and associated equipment.

22. Overhead Water-Tank

The **Overhead Water Tank (OWT)** at the Glass Factory of PV SO, NEI Complex is a critical utility structure with a storage capacity designed to provide emergency water, continuous supply to the utilities section, and firefighting support via a gravity-based distribution system. The tank is compartmentalized into four reinforced concrete sections for hydrostatic control and maintenance flexibility. A hollow shaft with an internal staircase provides safe vertical access for inspection, cleaning, valve operation, and repair, while also optimizing structural efficiency. The shaft and tank walls are geometrically designed to resist axial loads, bending moments, and hydrostatic pressure, with wall thickness tapering and trapezoidal tank walls enhancing stability. Dead storage at the top ensures overflow management and prevents overpressure. Construction features include water bars at joints to prevent seepage. Hydrostatic testing confirmed water tightness, and careful observation of structural drawings, plant orientation, and safety procedures highlighted the integration of design, operational reliability, and safety. Routine inspections and maintenance are emphasized to ensure long-term durability and readiness of the tank.

Fig. 22.1 OWT & Boom Placer

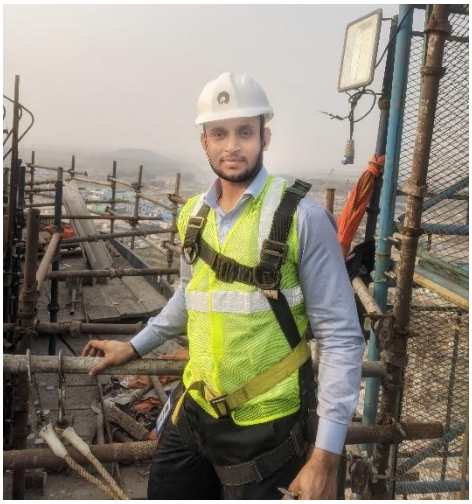
- Storage capacity: **10 lakh litres**
- Internal partitions: **4 compartments**; wall thickness: **0.3 m**
- Shaft base outer diameter: **7.1 m**, inner diameter: **4.7 m**, wall thickness: **1.2 m**
- Shaft top outer diameter: **5.7 m**, inner diameter: **4.7 m**, wall thickness: **0.5 m** above 15.5 m elevation
- Tank bottom outer diameter: **7.1 m**, inner diameter: **5.7 m**
- Tank top outer diameter: **17 m**, inner diameter: **16.4 m**
- Dead storage depth: **1 m**
- Water bars: **150 mm width**, **75 mm embedded** above and below construction joints
- Hydrostatic test duration: **7 days**, permissible water loss: **20 mm/day**
- Tank water level elevation: **EL 40.850 m**
- Plant orientation: **67.5° east from north**

Fig. 22.2 Overhead Water Tank Top View

Safety & Precautions

- **Personal Protective Equipment (PPE):**

  - Helmets, safety harnesses, full-body fall arrest systems, and non-slip footwear were mandatory during all site visits.
  - Safety harnesses and lifelines were properly anchored to secure points to prevent falls.



- **Heighted Areas:**

  - Scaffolding, ladders, and platforms were inspected for stability before use.
  - Movement on elevated structures was carefully coordinated to avoid collisions or slips.
  - Fall prevention systems and guardrails were in place wherever possible.

- **Confined Spaces:**

  - Entry was allowed only after proper quality checks & sign of employees and workers.
  - Adequate ventilation and lighting were ensured inside confined areas.

- **Site Protocols:**

  - Safety signs, barriers, and restricted zones were strictly followed.
  - Only authorized personnel were allowed in hazardous areas.
  - Supervision from site engineers and safety officers ensured compliance with safety standards.

- **4 E's of Safety:**

  - **Education:** Learning about site-specific hazards, safe practices, and emergency procedures.
  - **Engineering:** Using physical safety systems such as guardrails, scaffolds, harness anchorage points, and ventilation systems.
  - **Enforcement:** Following company and site safety rules strictly, including PPE compliance and restricted access protocols.
  - **Example:** Observing and following the safety behaviors of experienced engineers and supervisors to reinforce proper practices.

- **Overall Approach:**

  - All precautions collectively ensured a safe environment while allowing practical exposure to construction activities.
  - Reinforced the importance of proactive risk management and awareness during industrial projects.

Best Part of Field Orientation

The most valuable and memorable part of my field orientation was the opportunity to experience, observe, and understand a mega-scale industrial construction project at the Dhirubhai Ambani Green Energy Giga Complex, Jamnagar. Unlike classroom learning, where concepts are often limited to drawings and calculations, the field orientation allowed me to witness how large-scale planning, coordination, and execution are carried out in real time. The glass manufacturing factory, being a crucial part of the integrated photovoltaic manufacturing facility, demonstrated how different units such as raw material storage, batch house, melting furnace, forming section, deep processing, utilities, and finished goods handling are interconnected to achieve seamless production. Observing the layout and functionality of Train-1 and Train-2 helped me understand the importance of phased development, space utilization, and future expansion planning in industrial projects.

Another significant learning experience was observing construction methodologies, quality control practices, and engineering decision-making at site. The soil investigation process using borehole cutting methods due to hard rock strata gave me practical exposure to geotechnical investigations and foundation planning. Area grading, surface dressing, compaction procedures, and density testing using the sand replacement method helped me understand how ground preparation ensures long-term structural stability. Visits to the batching plant and quality control laboratory enhanced my understanding of concrete production, mix control, water quality testing, and temperature regulation during concrete placement. Concepts such as mass concrete behavior, temperature differentials, slip formwork, cable trenches, duct banks, and equipment foundations became much clearer after seeing their actual execution on site. Observing structures like pipe racks, vessels, pumps, compressors, cooling towers, substations, and control rooms helped bridge the gap between theoretical design and real-world implementation.

The strong focus on safety and professional discipline was another highlight of the field orientation. The mandatory use of personal protective equipment, strict adherence to site protocols, and controlled access to hazardous areas emphasized the importance of safety in industrial construction. Exposure to working at heights, confined spaces, and heavy equipment zones reinforced the need for awareness, teamwork, and supervision. The implementation of the 4 E’s of Safety—Education, Engineering, Enforcement, and Example—demonstrated how safety culture is built and sustained on large projects. Interaction with experienced engineers, supervisors, and safety officers provided valuable insights into site management, coordination among multiple agencies, and problem-solving under real constraints. Overall, the field orientation was an enriching experience that strengthened my technical understanding, improved my practical awareness, and motivated me to pursue a career in large-scale industrial and infrastructure projects.

THANK YOU